NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

HEADQUARTERS

SPACE TECHNOLOGY MISSION DIRECTORATE

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SPACE TECHNOLOGY MISSION DIRECTORATE,

COMMERCIAL SPACE TECHNOLOGY DEVELOPMENT – REQUEST FOR INFORMATION

NNH16ZOA001L

Request for Information Issued: ***January 14, 2016***

Request for Information Due: ***February 25, 2016 (5:00pm Eastern)***

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Commercial Space Technology Development – Request for Information

Responders are reminded:

REQUEST FOR INFORMATION (RFI): THIS IS *NOT* A REQUEST FOR PROPOSAL, QUOTATION, OR INVITATION TO BID NOTICE.

1.0 Introduction

The National Aeronautics and Space Administration (NASA) is continually looking for opportunities to advance the development of U.S. commercial space capabilities, products, and services. A key aspect of NASA's overall strategy is to stimulate the commercial space industry while leveraging commercial capabilities through public-private partnerships to deliver the technologies needed for future NASA missions.

On November 19, 2015, the Space Technology Mission Directorate (STMD) announced awards made under solicitation NNH15ZOA001N-15STMD-001, titled "Utilizing Public-Private Partnerships to Advance Tipping Point Technologies," to advance selected space technologies with fixed-priced contracts to a point beyond which industry, without further government investment, would willingly develop and qualify them for market. With this solicitation, hereafter referred to as the Tipping Point Appendix, NASA solicited proposals for technologies that enable or provide:

- robotic, in-space manufacturing and assembly of spacecraft and space structures,
- low size, weight, and power instruments for remote sensing applications,
- small spacecraft attitude, determination, and control sensors and actuators, and
- small spacecraft propulsion systems.

On the same day, STMD announced awards under solicitation NNH15ZOA001K, titled "Utilizing Public-Private Partnerships to Advance Emerging Space Technology System Capabilities" to offer government technical expertise and test facilities, as well as hardware and software technology transfer, to aid commercial space partners in maturing technologies to enable or enhance space vehicle systems or closely related subsystems. With this solicitation, hereafter referred to as the Announcement of Collaborative Opportunity (ACO), NASA solicited proposals for technology development focused on:

- suborbital reusable and small satellite launch systems development,
- wireless power transfer development,
- thermal protection system materials and systems development,

- green propellant thruster technology qualification, and
- small, affordable, high performance liquid rocket engine development.

NASA plans to release similar solicitations in the future to support the commercial space sector by continuing to invest in commercial space technologies that are at a “tipping point” in their development and by offering access to government capabilities. For the purpose of this Request for Information (RFI) and follow-on solicitations, a space technology is at a tipping point if an investment in a ground development/demonstration or a flight demonstration will result in:

- a significant advancement of the technology’s maturation,
- a high likelihood for utilization of the technology in a commercial space application, and
- a significant improvement in the offerors’ ability to successfully bring the space technology to market.

These commercial space technologies should have the potential to spur new markets and grow existing ones. Applicability to both the commercial and government sectors once the development/demonstration project completes is particularly beneficial. Tipping Point technologies should minimally have reached a Technology Readiness Level (TRL) of 3 at the time of proposal. A description of NASA’s TRLs is shown in Attachment A.

NASA is also interested in pursuing commercial space investments focused on early stage development, i.e. below TRL 3, for the Early Stage Portfolio. STMD programs with early stage content include NASA Innovative Advanced Concepts (NIAC), Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR), and Space Technology Research Grants (STRG). Finally, NASA is interested in developments that leverage academic partnerships to infuse technology into the commercial space sector. Both STTR and STRG specifically utilize academic partnerships to develop space technology.

More information about STMD programs is available at http://www.nasa.gov/spacetech.

STMD is seeking input through this RFI to inform topic areas for future Tipping Point appendices and ACO solicitations. STMD is also seeking input to develop new topics areas and concepts for the early stage portfolio and to develop academic/industrial partnerships of benefit to the commercial space sector.

2.0 Development Approach

NASA plans to follow up on the responses to this RFI by soliciting proposals in the next Tipping Point Appendix to advance compelling technologies that are of significant interest to the commercial space sector. Similarly, NASA plans to offer government capabilities through the next ACO solicitation to support commercial space vehicle and other space technology development. Plans to develop relevant technology content and new academic/industrial partnerships will feed into future requests for proposals for various STMD programs, especially in the Early Stage Portfolio. All plans for follow-on solicitations are tentative and subject to budgetary and programmatic constraints.

NASA is interested in understanding what space technologies are of greatest interest to the commercial space sector to advance their business plans, particularly where NASA support is desired. Technologies that could significantly benefit from partnerships that include the utilization of government facilities, personnel, or technology transfer should be noted. NASA is also interested in understanding low TRL technology areas that have commercial space application and would benefit from STMD's early stage development efforts. Academic/industrial partnerships to support the development of technologies and infusion into the commercial space sector should be emphasized. Finally, NASA is interested in identifying and understanding innovative partnering approaches to help remove barriers or obstacles to pursuing technology development with the commercial space sector.

For all potential technology concepts, NASA is interested in understanding approaches for accomplishing the development/demonstration under the most affordable terms possible. For developments requiring demonstration in space, affordable approaches such as hosted payloads, secondary payloads, small satellite platforms, and partnering with existing commercial and government flight programs are of interest. Approaches to achieving technology demonstration and maturation without performing a full spaceflight demonstration are of significant interest. For example, technology maturation approaches where a ground demonstration of a flight-like engineering/test unit or a key component technology would suffice to advance the technology to commercial readiness.

Note that responses to this RFI will be kept strictly confidential and used only for topic development for future solicitations in support of the commercial space sector.

3.0 Information Requested

The responses to this RFI should include the information listed below. Note that it is not necessary to respond to every question in detail, particularly if it is not applicable. The intended audience of this RFI is private sector companies operating in the commercial

space sector, but all organizations, including academia, NASA centers, other government agencies, nonprofit organizations, and individuals are invited to respond.

- **Company/Organization Information:** Company/organization name, address, a company description, point-of-contact name, e-mail address, and phone number.
- **Tipping Point Technology Description**: Provide a description of any applicable "tipping point" technology concepts (TRL 3 and above), noting the commercial capabilities they provide, comparisons to the current state of the art, and relevant performance metrics. Discuss why an STMD investment will mature the technology beyond the "tipping point," i.e. to a point at which the technology can be commercialized. Discuss the likely commercial market for the technology concept, including potential customers and the expected market size, and how this technology has the potential to significantly change the commercial market space.
- **ACO Technology Description:** Provide a description of any applicable commercial space technologies or concepts (TRL 3 and above) that would benefit from utilizing NASA's unique capabilities offered through the ACO (other than monetary awards). List the expertise and support including specific labor, facilities, technology transfer, etc. desired from NASA. Discuss the likely commercial market for the technology concept, including potential customers and the expected market size, and how this technology has the potential to significantly change the commercial market space. Discuss the likelihood of non-NASA funding or other resource contributions to support the work.
- **Early Stage Technology Concepts:** Provide a description of any applicable commercial space technology concepts at low TRL, i.e. 3 and below, that have potential for development through STMD's Early Stage Portfolio, or other STMD programs that serve the lower-TRL range, such as SBIR. Discuss the likely commercial market for the technology concept, including potential customers and the expected market size, and how this technology has the potential to significantly change the commercial market space.
- **Academic/Industrial Partnership Technology Concepts:** Provide a description of any applicable commercial space technology concepts that have potential for development through academic/industrial partnerships, including STTR, STRG, and other STMD programs with relevant opportunities. Identify possible academic partners and how the academic institution is leveraged to develop and infuse technologies for application to the commercial space sector. Discuss the likely commercial market for the technology concept, including potential customers and the expected market size, and how this technology has the potential to significantly change the commercial market space.
- **Innovative Public-Private Partnerships:** Suggest innovative partnering concepts that have the potential to minimize barriers to investment such as the type of contract vehicle, reporting requirements, intellectual property, etc. that limit, or eliminate the

opportunity for NASA investment/co-development of applicable commercial space technologies. Also, provide any recommendations that would encourage stronger participation of commercial space sector companies in NASA technology development activities. Discussing specific provisions of the previous Tipping Point Appendix and ACO will aid in improving them and encouraging future participation. For instance, the Tipping Point Appendix required a 25% corporate/customer contribution and utilized a fixed-price contracting approach. Alternatively, the ACO employed a non-reimbursable Space Act Agreement and required the commercial partner to contribute any hardware required for the co-development activity.

4.0 RFI Questions

If you have questions concerning this RFI prior to submitting a response, please send your questions to HQ-SpaceTech@mail.nasa.gov. NASA will review the questions and post a response in the Frequently Asked Questions (FAQs) document that will posted on the RFI Website in NSPIRES. Questions must be submitted by **February 11, 2016** to be considered by NASA for a response.

5.0 Submitting Responses

Responses to the STMD Commercial Space Technology Development Request for Information (NNH16ZOA001L) should be submitted via email to HQ-SpaceTech@mail.nasa.gov.

Responses are limited to no more than 8 pages and should be emailed as a single PDF file attachment not to exceed 10MB. The information provided in response to this RFI will not be disclosed publicly or used outside of the government for any purposes. The target audience of responders is primarily commercial entities but all potential partners and interested parties are welcome to response.

The information is requested for planning purposes only, subject to Federal Acquisition Regulation (FAR) Clause 52.215-3, entitled "Solicitation for Information for Planning Purposes." Provided the availability of funds, the Space Technology Mission Directorate will consider releasing a competitive Broad Area Announcement (BAA) that incorporates the results of this RFI. However, the release of this RFI does not indicate that the government will issue a solicitation nor does it obligate the government to invest any resources specific to the targeted technology areas offered in the responses to this market research activity.

Attachment A: Description of NASA Technology Readiness Levels

TRL	Definition	Hardware Description	Software Description	Exit Criteria
1	Basic principles observed and reported	Scientific knowledge generated underpinning hardware technology concepts/applications.	Scientific knowledge generated underpinning basic properties of software architecture and mathematical formulation.	Peer reviewed publication of research underlying the proposed concept/application.
2	Technology concept and/or application formulated	Invention begins, practical applications is identified but is speculative, no experimental proof or detailed analysis is available to support the conjecture.	Practical application is identified but is speculative; no experimental proof or detailed analysis is available to support the conjecture. Basic properties of algorithms, representations, and concepts defined. Basic principles coded. Experiments performed with synthetic data.	Documented description of the application/concept that addresses feasibility and benefit.
3	Analytical and experimental critical function and/or characteristic proof-of-concept	Analytical studies place the technology in an appropriate context and laboratory demonstrations, modeling and simulation validate analytical prediction.	Development of limited functionality to validate critical properties and predictions using non-integrated software components.	Documented analytical/experimental results validating predictions of key parameters.
4	Component and/or breadboard validation in laboratory environment.	A low fidelity system/component breadboard is built and operated to demonstrate basic functionality and critical test environments, and associated performance predictions are defined relative to final operating environment.	Key, functionality critical software components are integrated and functionally validated to establish interoperability and begin architecture development. Relevant environments defined and performance in the environment predicted.	Documented test performance demonstrating agreement with analytical predictions. Documented definition of relevant environment.

5	Component and/or breadboard validation in relevant environment.	A medium fidelity system/component brassboard is built and operated to demonstrate overall performance in a simulated operational environment with realistic support elements that demonstrate overall performance in critical areas. Performance predictions are made for subsequent development phases.	End-to-end software elements implemented and interfaced with existing systems/simulations conforming to target environment. End-to-end software system tested in relevant environment, meeting predicted performance. Operational environment performance predicted. Prototype implementations developed.	Documented test performance demonstrating agreement with analytical predictions. Documented definition of scaling requirements.
6	System/sub-system model or prototype demonstration in a relevant environment.	A high fidelity system/component prototype that adequately addresses all critical scaling issues is built and operated in a relevant environment to demonstrate operations under critical environmental conditions.	Prototype implementations of the software demonstrated on full-scale, realistic problems. Partially integrated with existing hardware/software systems. Limited documentation available. Engineering feasibility fully demonstrated.	Documented test performance demonstrating agreement with analytical predictions.
7	System prototype demonstration in an operational environment.	A high fidelity engineering unit that adequately addresses all critical scaling issues is built and operated in a relevant environment to demonstrate performance in the actual operational environment and platform (ground, airborne, or space).	Prototype software exists having all key functionality available for demonstration and test. Well integrated with operational hardware/software systems demonstrating operational feasibility. Most software bugs removed. Limited documentation available.	Documented test performance demonstrating agreement with analytical predictions.

8	Actual system completed and "flight qualified" through test and demonstration.	The final product in its final configuration is successfully demonstrated through test and analysis for its intended operational environment and platform (ground, airborne, or space).	All software has been thoroughly debugged and fully integrated with all operational hardware and software systems. All user documentation, training documentation, and maintenance documentation completed. All functionality successfully demonstrated in simulated operational scenarios. Verification and validation completed.	Documented test performance verifying analytical predictions.
9	Actual system flight proven through successful mission operations.	The final product is successfully operated in an actual mission.	All software has been thoroughly debugged and fully integrated with all operational hardware and software systems. All documentation has been completed. Sustaining software support is in place. System has been successfully operated in the operational environment.	Documented mission operational results.

Note: In cases of conflict between NASA directives concerning TRL definitions, NPR 7123.1 will take precedence.